BIOLOGICAL EVALUATION OF GYPSY MOTH

At

CATOCTIN MOUNTAIN PARK

2006

Prepared by

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ABSTRACT

In late summer and fall of 2006, USDI Park Service and USDA Forest Service personnel conducted gypsy moth egg mass surveys at Catoctin Mountain Park (CMP). The purposes of these surveys were to determine gypsy moth population densities, assess the potential for defoliation and the need for treatment in 2007. Current populations are sufficient to cause moderate defoliation on 1339 acres. Treatment is recommended to prevent defoliation and possible tree mortality.

METHODS

USDI Park Service personnel conducted a preliminary egg mass survey throughout CMP. This survey revealed high gypsy moth population levels in the eastern portion of CMP and a small area north of Camp No.3 while other areas of the park had relatively low gypsy moth population levels. USDA Forest Service personnel then conducted a more intensive survey that was concentrated in the eastern portion of CMP and in high use areas such as Green Top, Misty Mount, Chestnut Picnic Area, etc.

For both surveys, gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a 1/40th acre fixed radius plot was established. The plots consisted of a tally of all the new (2006) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre. During the intensive survey, egg mass lengths were measured at the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity.

RESULTS

The location of the survey plots established by the National Park Service are shown in Figure 1 and the summarized results of the survey are presented in Table 1.

Briefly, egg mass densities ranged from 0-3400 and averaged 248 egg masses per acre. Egg masses were detected on only 54% (45 out of 83) of the plots. The number of egg masses per acre were less than 200 in 76% (63 out of 83) of the plots. This survey revealed the highest concentration in the eastern portion of CMP and also a small area north of Camp No.3.

The location of the survey plots established by the USDA Forest Service are shown in Figure 2 and the summarized results of the survey are presented in Table 2. In brief, egg mass densities ranged from 0-6720 and averaged 1577 egg masses per acre. The average egg masses per acre were much higher for this survey than the preliminary survey because this survey was primarily concentrated in the eastern portion of CMP. Overall egg mass lengths tended to be large to extra-large in size, ranging from 18-60 mm and averaging 34 mm.

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

The survey results indicate that moderate defoliation is likely to occur on approximately 1306 acres in the eastern portion of CMP and 33 acres north of Camp No.3 in 2007 (Figure 3).

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and prediction defoliation. Using Liebhold's model, Figure 4, shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 1636 egg masses per acre (average egg mass density in the eastern portion of CMP) x 34 mm (average egg mass length) translates to a projected defoliation level of about 50 percent (moderate defoliation). Because egg mass densities and the host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately moderate throughout this area of CMP. Moderate defoliation (38%) is also projected for the small area north of Camp No.3. No defoliation is expected elsewhere at CMP in 2007.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed at CMP. The average egg mass length is 34 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at CMP in 2006. Although it is still possible that either the gypsy moth fungus or the NPV could cause the general collapse of the gypsy moth population next year, it is unlikely that populations will collapse prior to a significant defoliation event occurring in 2007.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to

deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light to moderate defoliation (<60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28 percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak saw timber and 14 percent of the total oak pole timber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas at CMP and the factors mentioned above, large areas of extensive tree mortality are not expected should defoliation occur in the absence of drought conditions in 2007. Mortality will be more prevalent if adequate rainfall is not received during the 2007 growing season.

Management Options

In 2007, two management options have been evaluated for managing gypsy moth populations at CMP. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure, branch dieback and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations (greater than 750 egg masses per acre) viral epizooics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal

activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels.

Although it is not possible to accurately assess such events with the defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations information at hand, it is unlikely that a collapse will occur in 2007 since most of these areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al., (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that moderate defoliation will occur in the eastern portion of CMP along with an area north of Camp No. 3 in 2007.

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk).* This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al., (1996) in West Virginia. Miller's study involved a large scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1 year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½ -1 gallon per acre. With

proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 4×10^{11} occlusion bodies (OB's) per acre applied in a single application or 2×10^{11} OB's per acre applied in a double application. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2007 should this insecticide be preferred for use at CMP.

Alternatives

With the previously described options in mind, the following alternatives are offered:

Alternative 1. - No action.

Alternative 2. - One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ½ gallon per acre.

Alternative 3. - Two aerial applications of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4. - One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of 1 gallon per acre.

Alternative 5. - Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations in the eastern portion of CMP along with an area north of Camp No. 3 are healthy, building and sufficient to cause moderate defoliation in 2007. To protect tree foliage and prevent subsequent tree mortality, our recommendation is for either alternative 2 (a single application of *Btk*), alternative 4 (a single application of Gypchek) or alternative 5 (a double application of Gypchek). Unless there is sufficient cause for concern regarding potential impacts of *Btk* to non-target lepidopterous larvae, a single application of *Btk* is the preferred recommendation.

This recommendation is based on the following considerations:

1) The current population density does not warrant a double application of *Btk*.

2) It is likely that a single application of *Btk* will provide adequate foliage protection and sufficiently reduce gypsy moth populations.

3) A single or double application of Gypchek is less likely to provide both adequate foliage protection and sufficient population reduction.

4) The cost of a single application of *Btk* is about one half that of a double application of *Btk*.

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Table 1. – Results of the gypsy moth egg mass survey conducted by National Park Service personnel at CMP, August – October, 2006.

Plot #	#em/acre
1	0
2	0
3	0
4	0
5	0
6	0
7	40
8	0
9	0
10	0
11	0
12	0
13	40
14	80
15	0
16	0
17	0
18	0
19	160
20	40
21	0
22	0
23	240
24	200
25	0
26	0
27	160
28	0
29	0
30	0
31	360
32	0
33	0
34	160

Plot #	em/acre
35	0
36*	800
37*	1600
38*	560
39*	1360
40	0
41*	1200
42	0
43	0
44	0
45	0
46	0
47	40
48	120
49	0
50	40
51	0
52	80
53	40
54	80
55	80
56	40
57	0
58	0
59	80
60	160
61	40
62	120
63	40
64	40
65	0
66*	0
67*	160
68*	1200

Table 1. (continued)– Results of the gypsy moth egg mass survey conducted by National Park Service personnel at CMP, August – October, 2006.

Plot #	#em/acre
69*	320
70*	480
71*	160
72*	0
73*	160
74	120
75	840

Plot #	em/acre
77*	240
78*	2160
79*	760
80*	3400
81*	1320
82*	760
83*	640

em/acre range = 0-3400
em/acre average = 248

* plot located within recommended treatment area.

Table 2. – Results of the gypsy moth egg mass survey conducted by US Forest Service personnel at CMP, October 18-30, 2006.

Plot #	#em/acre	em size (mm)	Plot #	# em/acre	em size (mm)
1*	360	32,24	35*	1520	40,42,44
2*	680	44,32	36*	2360	36,30,30
3*	1400	36,30,32	37	1040	44,36,36
4*	1440	36,34,42	38*	160	40
5*	4440	40,46,39	39*	1240	44,46
6*	1720	40,32,30	40*	120	—
7*	1800	34,36,36	41*	40	—
8*	4480	30,32,30	42*	3520	36,28,20
9*	5960	40,40,36	43*	2840	36,34,32
10*	1120	30,28,26	44*	3120	28,36,38
11*	3080	34,30,32	45*	5880	44,38,54
12*	3360	36,44,34	46*	360	60,32,32
13*	3560	46,36,38	47*	640	36,32,26
14*	2320	28,26,36	48*	2320	38,32,34
15*	1920	30,40,36	49*	2040	34,34,34
16*	720	28,46,28	50	40	34
17*	2640	36,44,42	51	120	—
18*	3120	32,48,38	52	0	—
19*	640	42,44,42	53	0	—
20*	6720	44,40,40	54	120	34
21*	3920	28,40,38	55	40	34
22*	640	24,24,28	56	0	—
23*	3040	36,36,30	57*	880	26,28,38
24*	2960	40,36,42	58*	3000	28,32,38,42
25*	1160	42,28,30	59*	1000	26,32,40,42
26*	320	32	60*	960	26,32,36
27*	1080	32,40,28	61*	3160	18,26,28,34
28*	440	36,32	62*	120	—
29*	320	32	63*	600	24,28,30,38
30*	960	30,24,38	64*	760	38,42,46
31*	120	44	65	200	28,30,36,38
32*	960	44,32,32	66	40	28
33*	880	28,32,34	67	40	46
34*	600	36	68	80	—

em/acre range = 0-6720
em/acre average = 1577

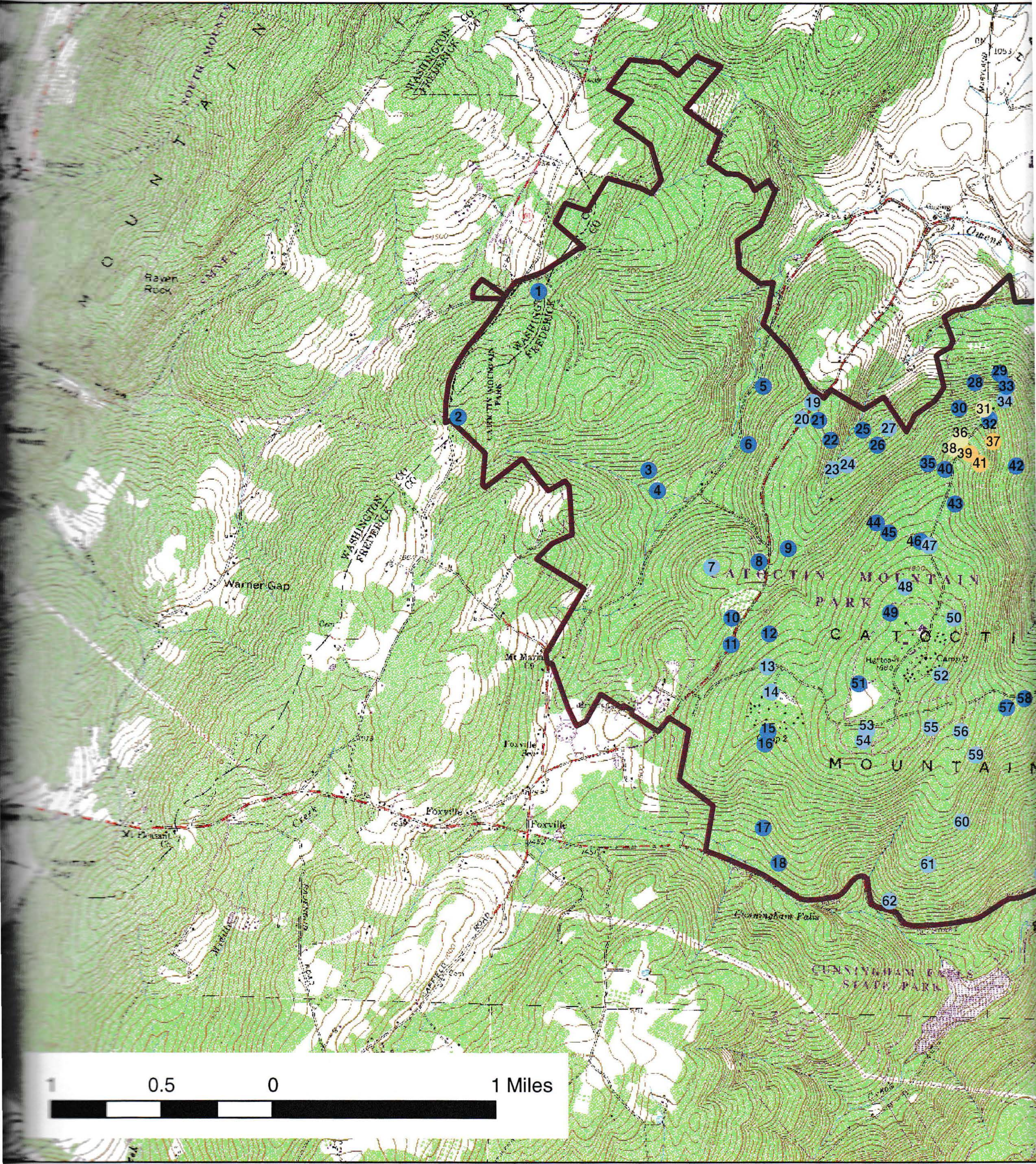
em size range (mm) = 18-60
em size average (mm) = 34

* plot located within recommended treatment area

** em/acre range in recommend treatment areas = 0-6720
em size range (mm) in recommended treatment areas = 18-60
em size average (mm) in recommended treatment areas = 34

** based on both USFS and NPS plots

Figure 1. -- Location of the gypsy moth survey plots at Catoctin Mountain Park, August to Octob



Dctober, 2006.

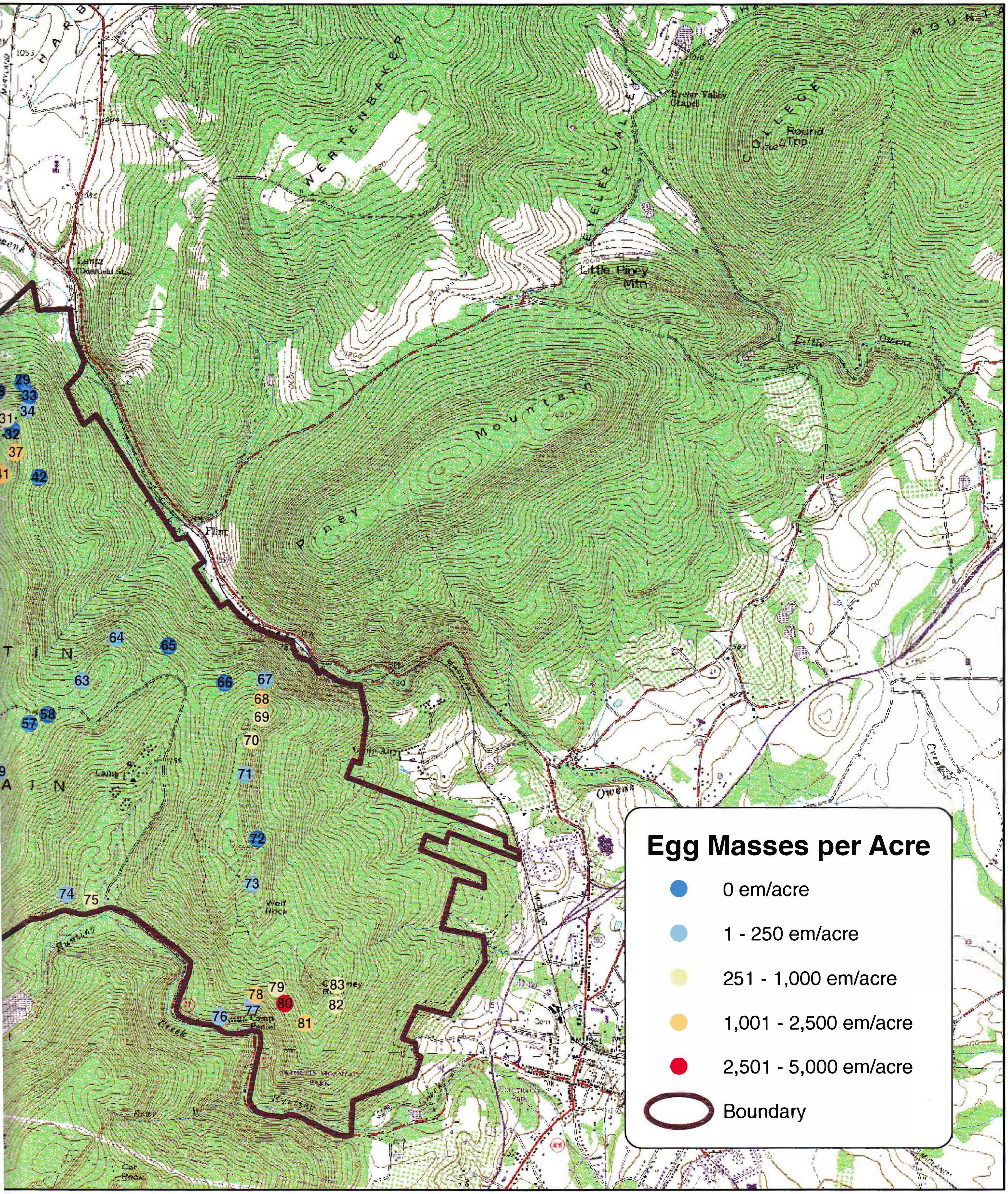
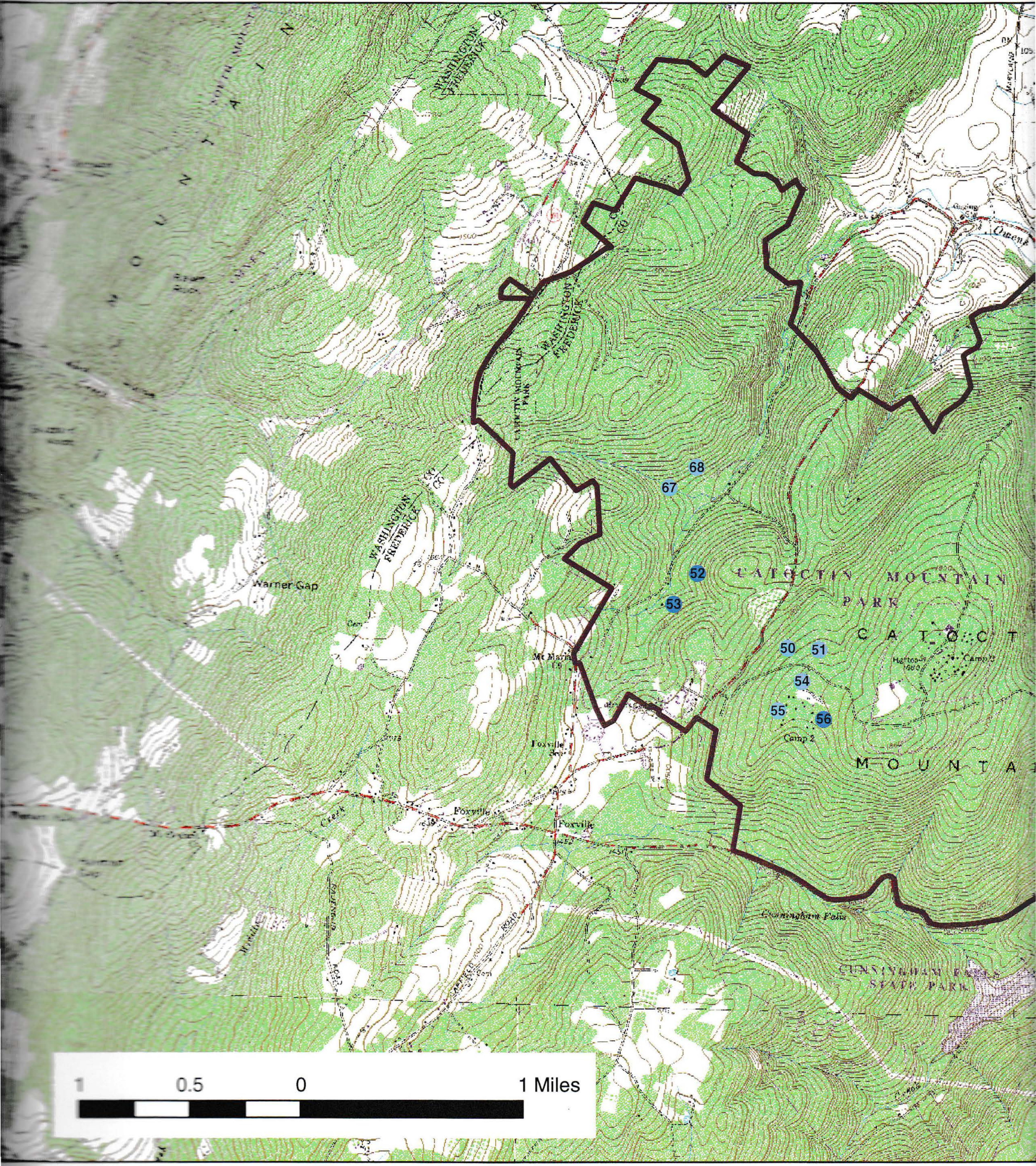


Figure 2. -- Location of the gypsy moth survey plots at Catoctin Mountain Park, October 18-30



3-30, 2006.

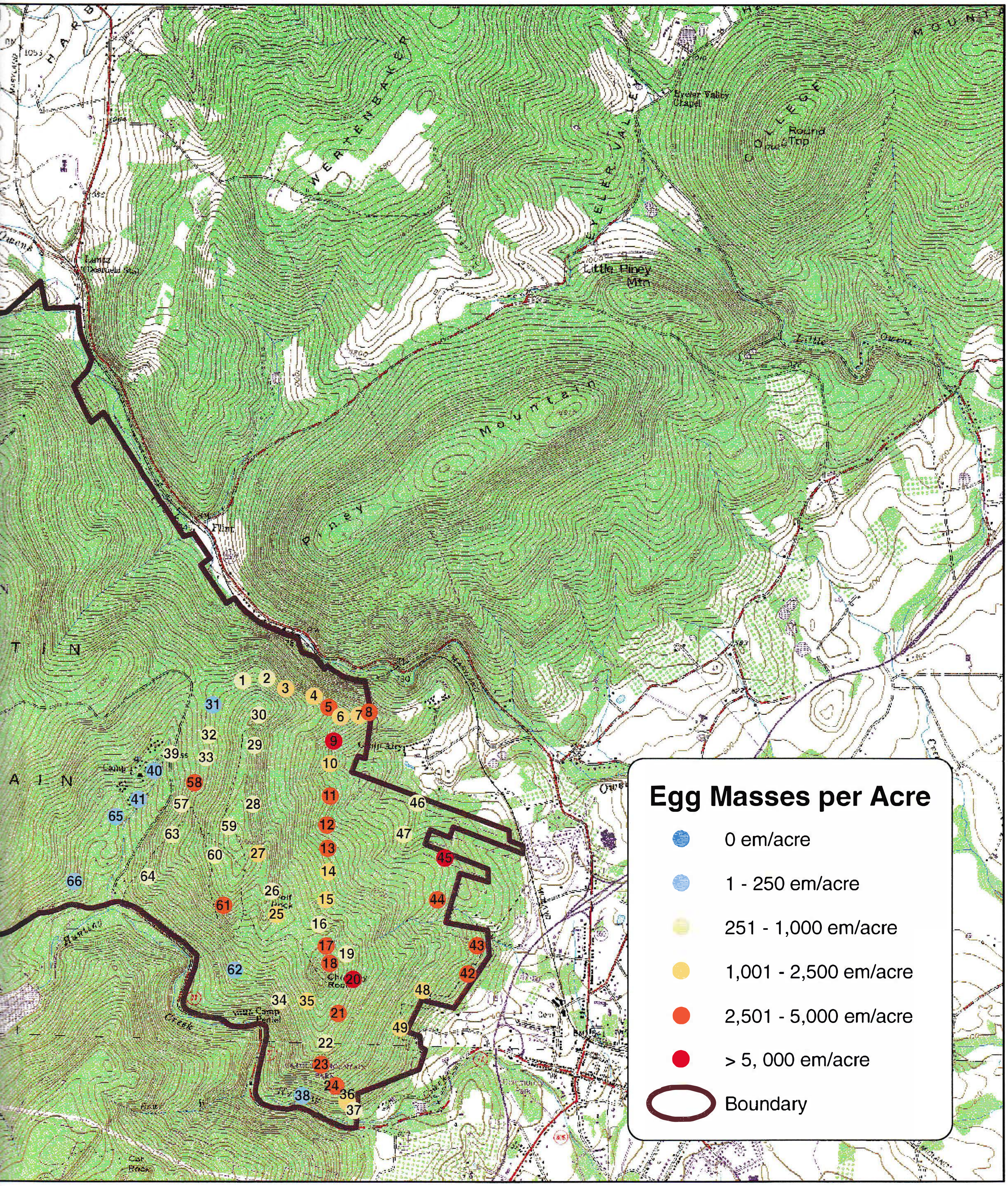
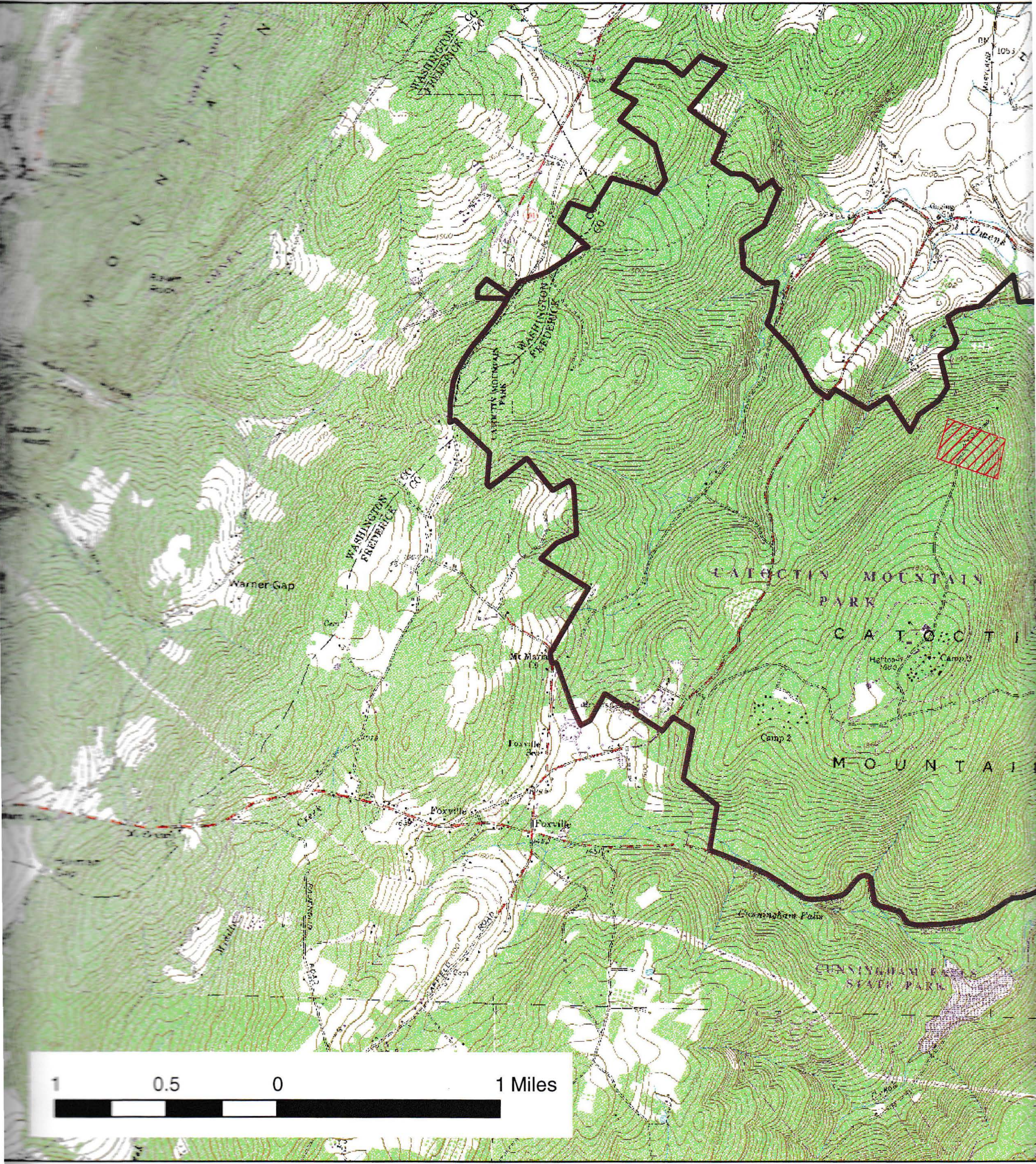
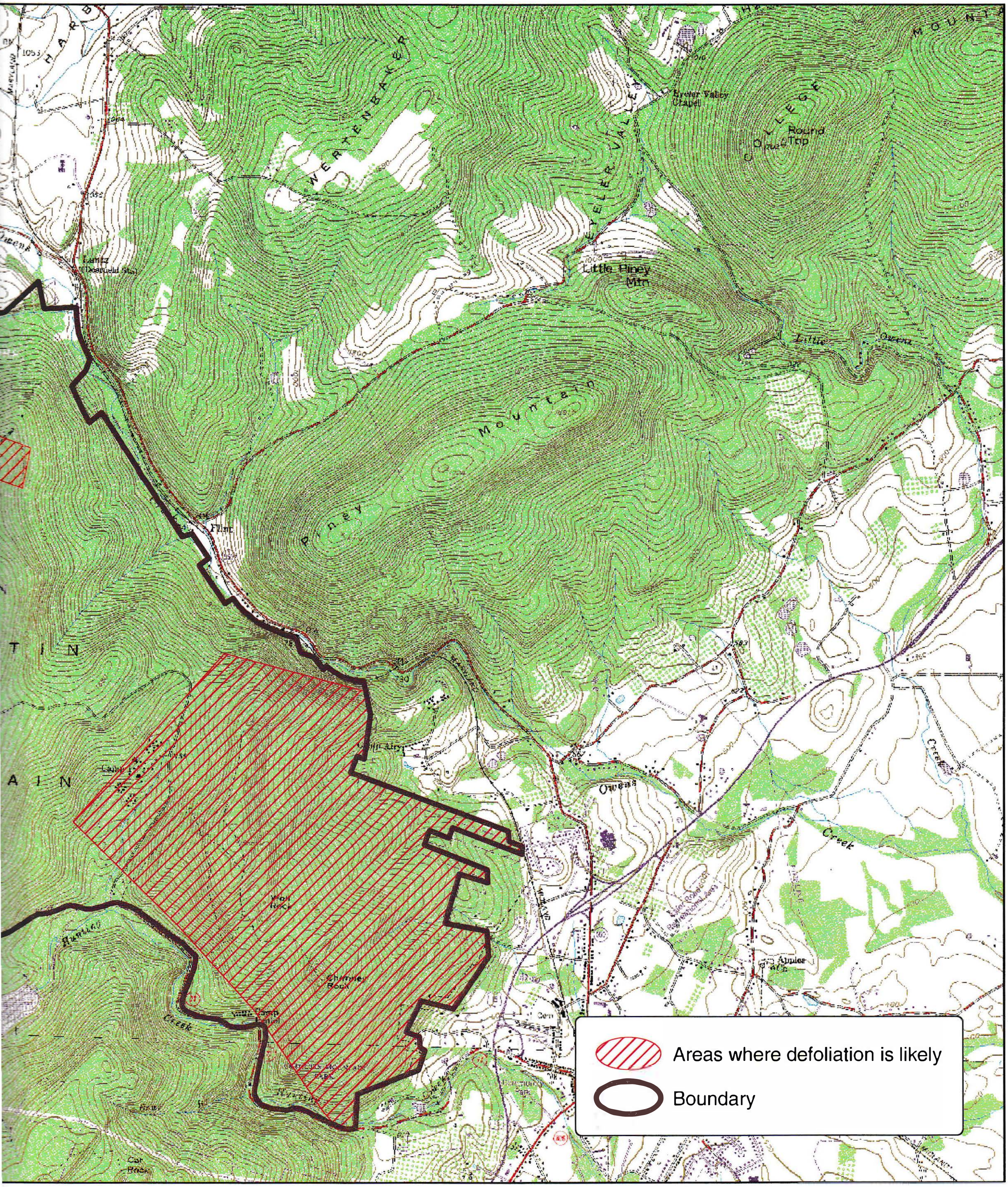

Egg Masses per Acre
0 em/acre
1 - 250 em/acre
251 - 1,000 em/acre
1,001 - 2,500 em/acre
2,501 - 5,000 em/acre
> 5, 000 em/acre
Boundary
Piney Mountain
Little Piney Mtn
Round Top
College
Wertenbaker
Little Owens

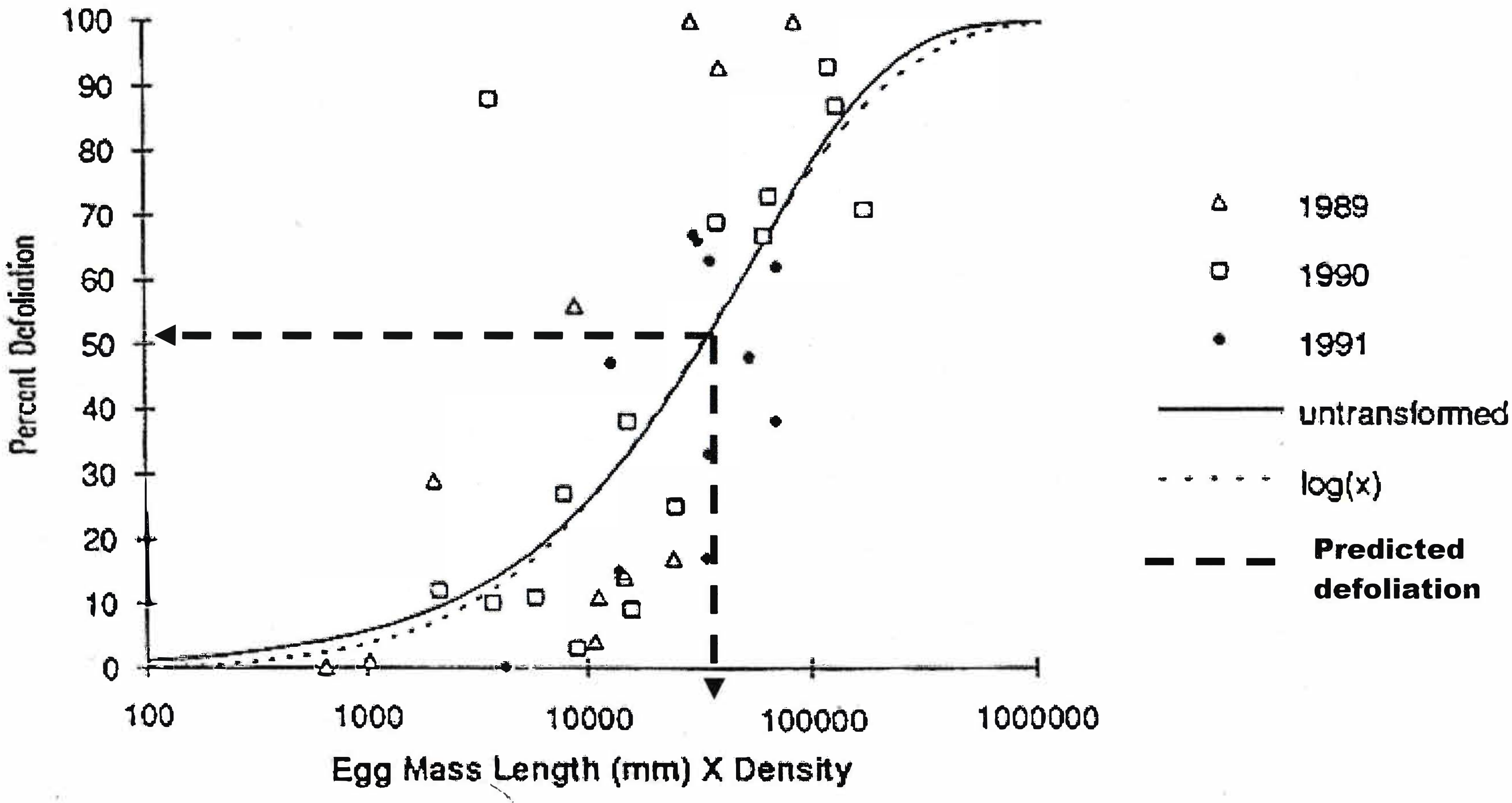
Figure 3. -- Areas where defoliation is likely/recomended treatment areas.





Areas where defoliation is likely
Boundary
Little Piney Mtn
Piney Mountain
Round Top
COLLEGE
WERTENBAKER
Little Owens
Owens
Creek
Creek
Apples

Figure 4.—Predicted defoliation in the eastern portion of Catoctin Mountain Park in 2007.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

USDA United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3410
Date: November 29, 2006

Mr. Mel Poole
USDI National Park Service
Catoctin Mountain Park
Thurmont, MD 21788

Dear Mr. Poole:

Enclosed is the gypsy moth biological evaluation for Catoctin Mountain Park.

In brief, gypsy moth populations are sufficient to cause moderate defoliation on 1306 acres in the eastern portion of the Park and 33 acres north of Camp No.3. We are recommending a single application of *Bacillus thuringienis* variety *kurstaki (Btk)* in these two areas. With good timing and proper application, gypsy moth defoliation should be minimal at Catoctin Mountain Park in 2007.

I would like to thank your staff for conducting the preliminary egg mass survey.

Please contact me at 304-285-1555 if you have any questions regarding the gypsy moth biological evaluation.

Sincerely,

Rodney L. Whiteman

RODNEY L. WHITEMAN
Forester
Forest Health Protection

Enclosure

Cc: James Voight, CMP
Jil Swearingen, CUE
Robert Tichenor, MDA
Betsie Handley, MDA

RLW/blm